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ACR–SNM–SPR PRACTICE GUIDELINE FOR THE PERFORMANCE OF GASTROINTESTINAL SCINTIGRAPHY

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was revised collaboratively by the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Nuclear Medicine (SNM).

This guideline is intended to guide interpreting physicians performing gastrointestinal scintigraphy in adult and pediatric patients. Properly performed imaging with radiopharmaceuticals that localize in or are introduced into the gastrointestinal tract or peritoneum is a sensitive means for detecting, evaluating, and quantifying numerous conditions affecting the alimentary tract and peritoneum. As with all scintigraphic studies, correlation of findings with the results of other imaging and nonimaging procedures, as well as clinical information, is necessary to achieve maximum diagnostic yield.

Application of this guideline should be in accordance with the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

II. DEFINITION

Gastrointestinal scintigraphy involves the intravenous, oral, transcatheter (to include enteric tubes), or intraperitoneal administration of a radiopharmaceutical that transits or localizes in the salivary glands, gastrointestinal tract, or peritoneal cavity, followed by gamma camera imaging, with or without computer acquisition. (For scintigraphy of the hepatobiliary tract or liver and spleen, see the ACR–SPR Practice Guideline for the Performance of Adult and Pediatric Hepatobiliary Scintigraphy and the ACR–SNM–SPR Practice Guideline for the Performance of Liver and Spleen Scintigraphy.)

III. GOAL

The goal of gastrointestinal scintigraphy is to enable the interpreting physician to identify and/or quantify anatomic or physiologic abnormalities of the salivary glands, gastrointestinal tract, or peritoneum.

IV. INDICATIONS

Gastrointestinal scintigraphy is generally indicated when more anatomic based studies have not been able to diagnose a cause for the patient's medical history, signs, and symptoms. Clinical indications are very broad. They include, but are not limited to:

1. Demonstration of salivary gland function and tumors.
2. Detection of ectopic functioning gastric mucosa.
3. Demonstration of the presence and site of acute gastrointestinal bleeding.
4. Verfication of suspected aspiration.
5. Evaluation and quantification of transit through and reflux into the esophagus.
6. Quantification of the rate of emptying of liquid and/or solid meals from the stomach.
7. Demonstration of transit through the small and large intestine.
8. Assessment of peritoneovenous shunts patency.
9. Detection of congenital or acquired perforation of the pleuroperitoneal diaphragm.
10. Demonstration of the presence or absence of peritoneal loculations prior to intraperitoneal chemotherapy or radiopharmaceutical therapy.

For the pregnant or potentially pregnant patient, see the ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation.

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

VI. RADIOPHARMACEUTICALS AND TECHNIQUE

Several radiopharmaceuticals are currently available. The radiopharmaceutical used should be chosen based on the clinical indications and circumstances.

A. Technetium-99m Sodium Pertechnetate

During the first 1 or 2 minutes after intravenous administration, this radiopharmaceutical may be used as a blood flow and "blood pool" marker. Within minutes after injection, technetium-99m pertechnetate begins to concentrate in gastric mucosa and salivary glands, making it a suitable radiopharmaceutical for detecting ectopic gastric mucosa and evaluation of the salivary glands. Normal renal excretion results in visualization of the kidneys and bladder. Rapid absorption by the stomach and peritoneum makes technetium-99m pertechnetate unsuitable for oral or intraperitoneal administration. The usual adult administered activity is 296 to 444 MBq (8 to 12 mCi) intravenously. Lower administered activity (111 to 185 MBq [3 to 5 mCi]) may be used if a flow study is not performed. Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

B. Technetium-99m Sulfur Colloid

Technetium-99m sulfur colloid when administered orally is not absorbed and is an excellent marker for imaging and quantification of numerous parameters of swallowing and gastrointestinal motility and transit. Administered activity of 18.5 to 74 MBq (0.5 to 2 mCi) is generally used as a radiolabel for liquid and solid meals. Its affinity for the protein matrix of egg white makes it easy to use to label egg as a solid-phase radio-pharmaceutical. Currently there are no standardized protocols or established normal values for pediatric studies. The administered activity of the radiopharmaceutical and the volume to be fed to the patient should be based on patient factors such as age, body weight, and the usual feeding volume. Administered activity for children should be as low as reasonably achievable for diagnostic image quality. Administered intraperitoneally, it is not absorbed and becomes a qualitative marker of movement of ascitic fluid through congenital or traumatic diaphragmatic fenestrations and peritoneovenous shunts.

C. Technetium-99m Autologous Red Blood Cells (RBCs)

Technetium-99m RBCs remain intravascular and are commonly used for detecting and localizing active gastrointestinal bleeding. The usual adult intravenous administered activity for gastrointestinal blood loss detection is 740 to 1,010 MBq (20 to 30 mCi). Administered activity for children should be determined

based on body weight, and should be as low as reasonably achievable for diagnostic imaging quality. The highest RBC labeling efficiency is with the in vitro method, which is recommended and widely used. See the ACR–SNM–SPR Practice Guideline for the Performance of Cardiac Scintigraphy.

D. Technetium-99m (Stannous - Sn) Diethylenetriamine-Pentaacetic Acid (DTPA)

Given orally, technetium-99m (Sn) DTPA may be used as a liquid-phase marker of gastric emptying or of small bowel transit when only a single liquid meal transit study is performed. It cannot be used simultaneously for a combined liquid-phase and solid-phase gastric emptying study when a technetium-99m solid-phase radiopharmaceutical is also used. When dual-phase (solid and liquid) gastrointestinal studies are performed indium-111 DTPA is used to measure the liquid phase and technetium-99m sulfur colloid is used for the solid phase.

The administered activity for technetium-99m DTPA is 18.5 to 37 MBq (0.5 to 1.0 mCi) for adults. Currently there are no standardized protocols or established normal values for pediatric studies. The administered activity of the radiopharmaceutical and the volume to be fed to the patient should be based on patient factors such as age, body weight, and the usual feeding volume. Administered activity for children should be as low as reasonably achievable for diagnostic image quality.

E. Technetium-99m Macroaggregated Albumin (MAA)

Given intraperitoneally, technetium-99m MAA is not absorbed and becomes a qualitative marker of the movement of ascitic fluid through peritoneovenous shunt devices or congenital/traumatic diaphragmatic fenestrations.

The usual adult administered activity is 0.5 to 5.0 millicuries (18.5 to 185 MBq). Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

F. Indium-111 DTPA

Given orally, with an administered activity of 5.55 to 18.5 MBq (0.15 to 0.50 mCi), indium-111 DTPA may be used as a liquid-phase marker of gastric emptying or for measurement of small bowel or colon transit. For a liquid only gastric emptying study, technetium-99m-sulfur colloid should be used instead of indium-111 DTPA to reduce radiation exposure.

Administered activity for children should be based on body weight and should be as low as reasonably achievable for diagnostic image quality.

VII. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for gastrointestinal scintigraphy should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

A. Ectopic – Gastric Mucosa (Meckel's scan)

The radiopharmaceutical technetium-99m pertechnetate is given intravenously. A rapid sequence of images (blood flow/angiographic phase) taken at 1 to 3 seconds per frame, over 1 minute, may be obtained in the anterior projection to evaluate the presence of hypervascular abdominal lesions that could be mistaken for ectopic gastric mucosa. Immediate serial imaging for 30 to 45 minutes can then be acquired as serial static views (300,000 to 500,000 counts per image) or continuous cine views (30 to 60 seconds per image). Continuous cine imaging is preferred to better visually discriminate normal physiologic activity (such as renal activity) from ectopic gastric mucosa. A lateral view can be useful to identify renal activity and retrovesical ectopic gastric mucosa. The study may be supplemented with oblique, postvoid single photon emission computed tomography (SPECT) imaging or delayed views of the abdomen, as indicated. Pharmacologic enhancement may be used with H2 blockers (cimetidine, famotidine, or ranitidine) to enhance free pertechnetate retention, and/or glucagon to decrease gastrointestinal peristalsis. Prone or right anterior oblique positioning may be used to delay gastric emptying into the small bowel, if the patient has not been pretreated with H2 blockers.

B. Gastrointestinal Blood Loss

All methods for diagnosing and localizing an active bleeding site require that the patient be actively bleeding and imaged during the time the radiopharmaceutical is present in the blood pool. Although this procedure is generally used for gastrointestinal bleeding, it can be useful for other sites of active bleeding.

Technetium-99m RBCs

The use of technetium-99m labeled red blood cells is the recommended method, since they remain intravascular and permit a longer imaging time. The radiolabeled cells are injected intravenously. Blood flow/angiographic phase and continuous cine or images of the abdomen are obtained for 60 to 120 minutes. Cine images (maximum of 15 seconds per image) and display are preferred as these improve the initial detection and more accurate localization of subtle gastrointestinal bleeding sites. Oblique, lateral, or delayed static abdominal images may be obtained to supplement the basic examination. If the study is negative, continued imaging may be appropriate.

C. Salivary Gland Imaging

The patient is positioned in front of a gamma camera with the face in the Water's (nose-chin) position. Technetium-99m pertechnetate is given intravenously. The usual adult administered activity is 185 to 370 MBq (5 to 10 mCi) intravenously. Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality. Serial images of the face are obtained over a period of 30 minutes. If needed, these views may be supplemented by oblique or lateral static images of the head and neck.

The collimator face should be protected using a plastic-backed pad or other similar material, especially if an external salivary fistula is suspected.

A sialogogue, such as lemon juice, may be used to stimulate salivary gland emptying in cases of salivary duct obstruction, sialadenitis, or suspected Warthin's tumor. The position of palpable nodules should be confirmed using a radioactive source marker.

D. Esophageal Transit

Scintigraphy of esophageal transit may yield unique and useful physiologic information about esophageal motility in patients with conditions (e.g., scleroderma, stricture, achalasia) that cause impaired transit of esophageal contents from the pharynx to the stomach or following therapy for these conditions. The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the

clinical circumstances, but in most cases 4 hours would be sufficient.

Data are collected in the posterior projection. As with barium esophagography use of multiple (up to 5) dry swallows can increase the sensitivity of the study to detect an abnormal swallow. Comparison of at least one upright and one supine swallow can be helpful to differentiate disorders such as achalasia from scleroderma. Many techniques have been described. Most involve the patient swallowing 7.4 to 37 MBq (0.2 to 1.0 mCi) of technetium-99m sulfur colloid in 10 to 15 mL of water, or a semisolid as a bolus. The initial rapid bolus transit should be recorded in a dynamic mode of 0.25 to 1 second per frame and reviewed visually using a cinematic (movie) display to evaluate the bolus transit. Additional data acquisition for up to 10 minutes where the patient may be asked to dry swallow to measure clearance from the esophagus and to look for possible gastroesophageal reflux is also helpful.

The normal value for esophageal bolus transit time is generally under 5 seconds, although each facility should validate its own normal range for its specific technique or should closely follow a validated technique and normal range from the literature.

Additionally, time-activity curves may be generated for the proximal, middle, and distal portions of the esophagus, but visual inspection of the cine bolus transit is more important for differentiating the various primary esophageal motor disorders [1].

E. Gastroesophageal Reflux

Scintigraphy for gastroesophageal reflux may give unique and useful physiologic information in patients whose history, signs or symptoms suggest possible incompetence of the gastroesophageal sphincter associated with acute or chronic reflux of gastric contents into the esophagus. In adults, a gastroesophageal reflux study using an abdominal binder is rarely performed by itself to look for reflux [2]. Observation of gastroesophageal reflux however during an esophageal transit study can be important as an etiology to reflux esophagitis and associated esophageal dysmotility [1].

In infants and children, a gastroesophageal reflux study is often combined with a liquid gastric emptying study. Several techniques have been described. The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient. A liquid meal consisting of formula, milk, or orange juice containing an appropriate concentration of technetium-99m sulfur colloid is administered orally, by nasogastric tube, or by

gastrostomy tube. The patient is then positioned supine beneath the gamma camera head, and serial 10 second to 30 second images of the esophagus and stomach are obtained. It is often appropriate to study small children in the supine position with the gamma camera detector under the imaging table. In adults, a Valsalva maneuver or an abdominal binder may be of benefit. Use of an abdominal binder is contraindicated in children.

The number of reflux events detected during the recording session, the duration, and the proximal extent of reflux may also be reported. The examination may be repeated using medications to assess the effectiveness of pharmacologic intervention.

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F.   Gastric Emptying

The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient. Three approaches are used: liquid phase, solid phase, and combined liquid-solid phase. In general, the liquid phase is preferred in infants and the neurologically impaired, whereas the solid phase is used when the patient is capable of ingesting solid food. In both cases, the "meal" needs to be introduced into the stomach fairly quickly (i.e., within 10 minutes). It is a good general practice to cover the camera heads with protective wrap to prevent contamination. Computer acquisition is required to determine the half-time of emptying and/or percent of emptying and to generate gastric emptying time-activity curves. Several techniques have been proposed. Examples include the following:

1.   Solid phase meal gastric emptying in adults

The SNM and the American Neurogastroenterological and Motility Society (ANMS) have recently published a consensus guideline on the scintigraphic measurement of gastric emptying in adults [3]. The report's recommendations are based on consensus and a multi-institutional investigation of 123 normal subjects using a standardized protocol and resulting established normal values [4]. This consensus recommendation addresses the problems associated with comparing results between imaging centers not using the same meal or imaging protocol. The ACR and the SNM support adoption of the recommendations of this consensus guideline and recommend adoption of its recommendations on normal values, patient preparation, study acquisition,

and processing. The guideline recommends use of a low-fat, egg-white meal with 1-minute static imaging at 0, 1, 2, and 4 hours after meal ingestion. The meal should be ingested within 10 minutes and gamma camera images obtained in anterior and posterior projections with the patient upright, if possible. Details can be found in the appendix to the consensus guideline [5].

2.   Liquid phase gastric emptying

For some time liquid phase gastric emptying studies have not been used since it was believed that abnormal liquid gastric emptying was a late phenomenon and a solid meal would detect abnormal gastric emptying better than a liquid meal. Recent studies suggest that liquids may detect some patients with abnormal gastric emptying when solid gastric emptying is normal. There are, however, no consensus recommendations at present on the best liquid phase gastric emptying meal or protocol.

Technetium-99m sulfur colloid or technetium-99m (Sn) DTPA is mixed with an appropriate volume (30 to 240 mL) of liquid carrier (e.g., orange juice, formula, milk) and is introduced into the stomach by swallowing, nasogastric tube, orogastric tube, or gastric tube depending on the clinical situation, in consultation with the referring clinician. The patient is positioned standing or supine with the camera anteriorly or left anterior oblique (LAO) over the abdomen. If a single-detector camera is used, a posterior image can be obtained immediately after the anterior image. If a dual-detector camera is available, anterior and posterior images can be obtained simultaneously. Posterior imaging may be appropriate in children. Sequential imaging and computer data acquisition are performed over the course of 30 to 60 minutes. A region of interest (ROI) is drawn over the stomach, and a decay-corrected time-activity curve is generated. In adult patients, the radiopharmaceutical exits from the stomach in an approximately exponential fashion for liquid meals. In children, imaging is usually performed during the first hour, and the percent of emptying is obtained at 60 minutes and later, if indicated. Unfortunately, currently no well defined normal values exist for the various liquid meals used. Each facility must validate its own normal range for its specific meal and technique.

Liquid phase gastric emptying ("milk scan") studies are most commonly performed in children. Liquid phase gastric emptying may be

combined with evaluation of esophageal motility, gastroesophageal reflux, and aspiration. The radionuclide esophagram may be performed initially or following the completion of the gastric emptying portion of the examination. For the esophagram, the patient is placed in the supine position with the gamma camera posteriorly positioned. Dynamic images of the esophagus ("radionuclide esophagram") 5 seconds/frame for 2 to 3 minutes are obtained for evaluating esophageal motility and possible aspiration. If the patient is normally fed by mouth, this may be accomplished as the initial part of the gastric emptying procedure, which is then followed by continuous imaging of the chest and abdomen for 60 minutes for evaluation of the presence and severity of gastroesophageal reflux. Gastric emptying at 60 minutes and at 2 or 3 hours after completion of feeding is calculated. Activity within the lungs confirms pulmonary aspiration. If the patient is not orally fed, the esophagram should be performed at the end of the gastric emptying study using a small volume of radiolabeled sterile water or saline.

3. Combined liquid-phase and solid-phase gastric emptying and small bowel and colon transit studies

A solid-phase study (see section VII.F.2 above) may be combined with the liquid-phase study (see section VII.F.1 above), using indium-111 DTPA for the liquid phase and technetium-99m sulfur colloid for the solid phase. With the use of properly administered doses it is possible to acquire data simultaneously using photopeaks of both radionuclides. Combined solid-phase and liquid-phase studies are most commonly used when there is a clinical need to follow the liquid phase to measure small bowel and colon transit. The long half-life of indium-111 DTPA permits imaging of activity in the bowel for up to 72 hours [5].

G. Aspiration of Gastric or Pharyngeal Contents

These studies are usually limited to pediatric patients or as a preoperative pulmonary evaluation for lung transplantation. The radiopharmaceutical used is technetium-99m sulfur colloid. The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient.

1. Aspiration of pharyngeal contents

A small volume (up to 1 mL) of technetium-99m sulfur colloid containing no more than 18.5 MBq (0.5 mCi) is placed on the dorsal surface of the posterior portion of the tongue. Images of the chest are obtained in the posterior projection over the course of 30 to 60 minutes. Radioactivity detected in the bronchi or lungs confirms aspiration.

2. Aspiration of gastric contents

Radioactive markers are placed for anatomic reference. An administered activity of 18.5 MBq (0.5 mCi) of technetium-99m sulfur colloid is placed in a small amount of the patient's feeding, administered orally, by nasogastric tube, or by gastrostomy tube depending on the clinical situation and in consultation with the referring clinician. If the material is administered orally, once the feeding is completed, an additional nonradioactive liquid feeding is given to clear any remaining radioactivity from the esophagus. Images of the thorax are obtained immediately after ingestion (as a baseline) and serially for 60 minutes thereafter. In infants and children, evaluation for aspiration of gastric contents is included as a routine component of the radionuclide gastric emptying and gastroesophageal reflux study (see sections E and F). Radioactivity seen in the lungs confirms the diagnosis of aspiration. Imaging is terminated after the radioactivity has cleared from the stomach.

H. Peritoneal Imaging

1. Evaluation of patency of peritoneovenous shunts

Technetium-99m sulfur colloid or technetium-99m MAA is administered in an administered activity of 18.5 to 185 MBq (0.5 to 5.0 mCi) directly into the peritoneal cavity, using aseptic technique. On occasion, normal saline (50 to 200 mL) can be used to facilitate distribution. An immediate image over the abdomen may be helpful to determine that the radiopharmaceutical is intraperitoneal and not loculated. If the shunt is functioning correctly, serial images obtained over 1 or 2 hours will reveal radiopharmaceutical in the shunt tube, and radioactivity will eventually appear in the liver and spleen (with technetium-99m sulfur colloid – see section VI.B) or lungs (with technetium-99m MAA).

2. Detection of congenital fenestrations or traumatic perforations of the diaphragm

   Technetium-99m sulfur colloid or technetium-99m MAA is administered intraperitoneally as described in section VII.H.1. Occasionally, the radio-pharmaceutical can be instilled with up to 500 mL of sterile normal saline in order to facilitate movement into the pleural cavity. If activity appears in the pleural space, the diagnosis of perforated diaphragm is confirmed.

3. Demonstration of peritoneal loculation of fluid

   Technetium-99m sulfur colloid or technetium-99m MAA is administered intraperitoneally as described in section VII.H.1. Immediate and delayed static images over the abdomen will reveal the distribution of the radiopharmaceutical in the peritoneal cavity.

VIII.   DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

The report should include the radiopharmaceutical used and the dose and route of administration, as well as any other pharmaceuticals administered, also with dose and route of administration.

IX.   EQUIPMENT SPECIFICATIONS

A gamma camera with a low-energy all purpose (LEAP) or high-resolution collimator is used for technetium-99m labeled radiopharmaceuticals. A medium-energy collimator is needed for indium-111. SPECT or SPECT/CT may also be useful.

X.   RADIATION SAFETY

Radiologists, imaging technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as "as low as reasonably achievable (ALARA)."

Facilities, in consultation with the radiation safety officer, should have in place and should adhere to policies and procedures for the safe handling and administration of radiopharmaceuticals, in accordance with ALARA, and must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by state and/or other regulatory agencies. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol.

XI.   QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR policy on Quality Control Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web page (http://www.acr.org/guidelines).

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras.

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Suggested Reading (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

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